



WITHOUT THE PRODUCT, THERE IS NO PROCESS!



2012

Jan

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Combined Resources Forum

Presents:

GSFC Scheduling Basics

for the Resources Community

Presenters: Jonathan Bryson, Chris Caldwell, and Steve Brill

January 2013

Workshop Purpose

This is a follow-up workshop to the Combined Resources Forum presentation entitled: Planning and Scheduling for the Resource Analyst.

This is a **pilot** session and it is not intended to teach how to build and develop schedules.

The objectives are to offer Resources staff an understanding on how to extract useable information from schedules which will help you to better relate to your respective projects, accomplish your jobs and grow within the Resources community.



For presentation material visit: <http://fpd.gsfc.nasa.gov/bci-intro.html>

What is a Schedule?

A **SCHEDULE** may be a “picture” of an entire project or a magnification of any part or level thereof.

It can establish the sequence of activities; indicate future work loads; identify key events; visually indicate the critical path; and be used to highlight the distribution of resources necessary to support the project.



What Scheduling Does

- **Plans, monitors and provides controls for the entire project:**
 - Measures performance against the baseline
 - Identifies potential risks
 - Allows performing “what-if” scenarios
 - Analyzes work-around options if delays occur
 - Forecasts start and completion dates (early or late)

This enables accurate, time-phased, budgets

Why Should You Care about Schedules?

- Resources staff are the supporting Research and Development, the building of Spacecraft, Instruments, Balloons, Mission Operations, Facilities, et cetera
- For example, a Resources Analyst (RA) may be assigned a Project element such as an instrument on a spacecraft or a ground system.
- All of the work for this element must be planned over a period of time or “scheduled.”
- Both schedule and cost performance must be tracked, managed and forecasted.
- The Financial Manager (FM) and Deputy Project Manager for Resources (DPMR) must understand cost plans and schedules for all Project elements.

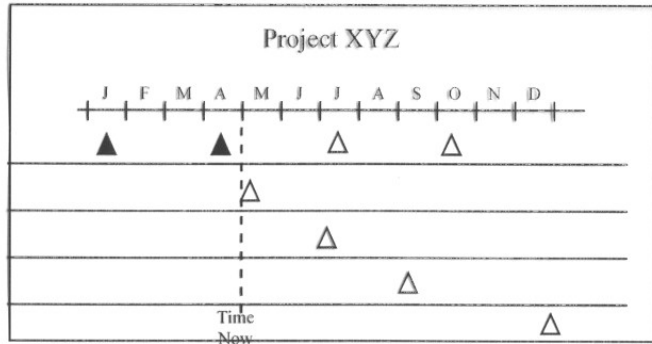
A Delicate Balance



Schedule, Cost and Scope are traded off to achieve an optimal balance.

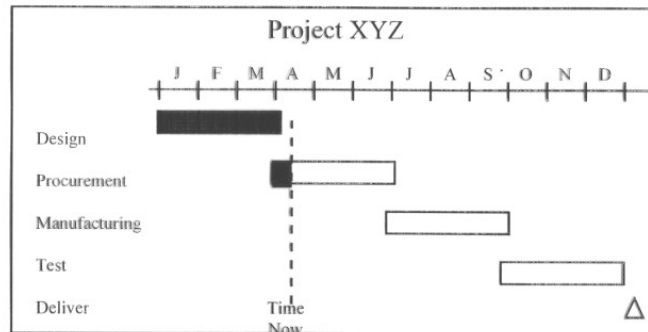
The RA is in a key position to observe and support the tradeoff discussions.

Schedule Types



Milestone Schedule:

Is a summary level schedule that identifies significant events (milestones) that may exist over the course of a project.

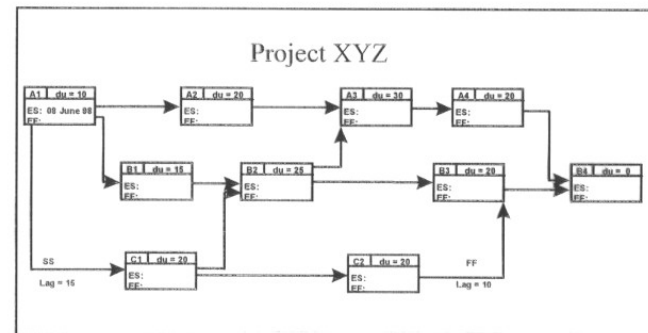


Bar/Gantt Chart:

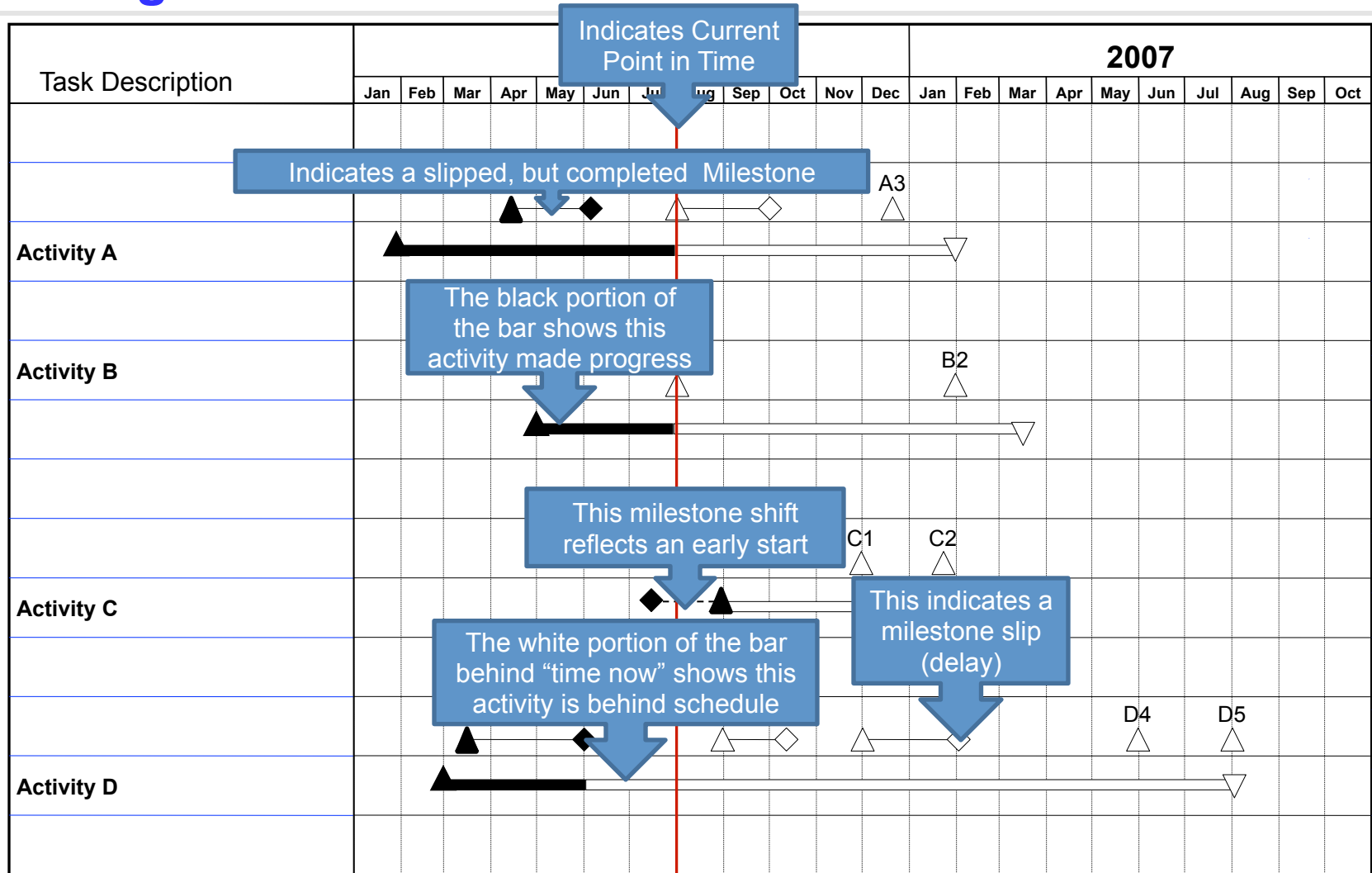
The left side of the chart displays the WBS, the date ribbon is placed across the top, and the activity durations are represented by horizontal bars.

Critical Path / Network Diagram:

Schematic of all logical relationships and activities. The network flows time-wise left to right to reflect the chronology of project work.



Reading the Gantt/Bar Chart



△ Event/Milestone Planned Start

▲ Event/Milestone Actual Start

— Planned Activity

■ Actual Activity

▽ Event/Milestone Planned Complete

▼ Event/Milestone Actual Complete

◇ Anticipated Slip

◆ Actual Slip

Case Study # 1

Exploring a Top-Level Schedule Chart

Frequently Used Terms

CASE #1: Supporting Information

- **Milestone:** A specified event in the plan used to measure progress. Defined as beginning or ends of activities. A milestone is visually depicted on a schedule chart as triangle.
- **Activity:** An activity is an identifiable work element; finite, discrete task. Its start and finish date are measureable.
- **Duration:** The duration is the estimated amount of time necessary to accomplish a task in “work units” (e.g. days).
- **Early Start/Early Finish:** These are the earliest dates a given activity can start or finish on without impacting its successor activity.
- **Late Start/Late Finish:** These are the latest dates a given activity can start or finish on without slipping the schedule.
- **Schedule Baseline:** When the schedule is approved by the PM it is baselined to lock in the planned working dates. The baseline start and finish dates are the dates the project agrees to start and finish their activities on. Progress is measured against these dates.
- **Critical Path:** The longest path per the time available through a project, or the path through the project with the least amount of float.

Standard Schedule Symbolology

CASE #1: Supporting Information



Major Milestone



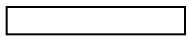
Planned Start Milestone



Planned Finish Milestone



Reschedule



Span of Activity



Progress of Activity



Changed Milestone w/# slips



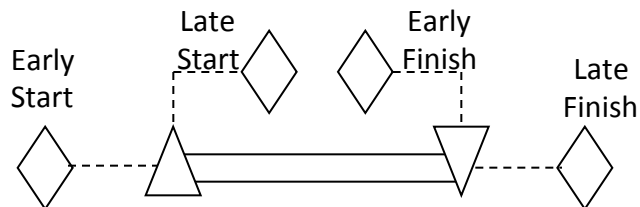
Completed Start Milestone



Completed Finish Milestone



Completed Reschedule



Milestone



Reschedule #



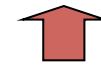
Complete



Major Milestone



Reschedule #



Complete



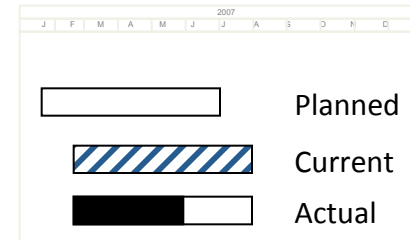
Reschedule #



Complete



Critical Path



Resources Life on a Project...

CASE #1: Problem

- You are a Resources Analyst or Project Support Specialist supporting XYZ Project.
- Project XYZ is an environmental satellite which will study the Earth's Carbon Cycles.
- At the project's Monthly Review, you received a copy of the presentation which included several schedule charts.
- Dialogue from the technical managers for the Spacecraft, Instruments and Ground System at the Monthly Review raised some questions in your mind:
 - Using the information that you have taken back to your desk, what possible questions would you have related to the schedule charts?
 - How might the schedule depiction assist you in understanding the impact to business activities and resources?
 - Does the current status give you any indications of additional financial or resource questions you could pose to your FM/DPMR?

Discussion Details

CASE #1: Problem

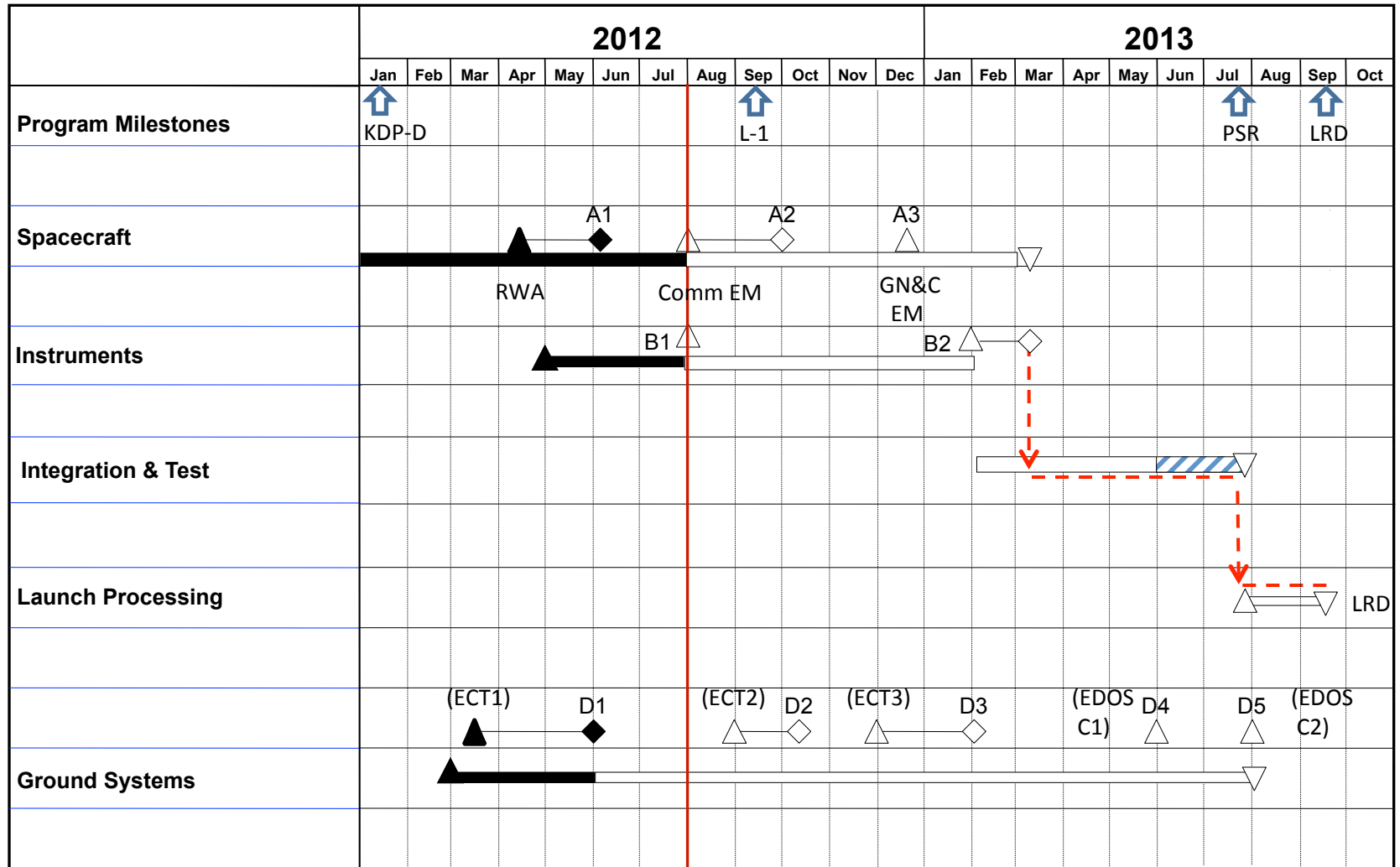
During the Project monthly, you heard the following types of technical points being discussed:

- On the Integrated Master Schedule (IMS) Chart:
 - The Communications Equipment Module Harness (Milestone A2) is suffering from a late delivery from one of the key part vendors. As a result, the delivery of the harness will be delayed, and is reflected on the schedule. The harness is a key component for the instrument integration efforts.
 - The Communications Equipment Module Harness (Milestone A2) was unable to start as planned and has minor delay with some impacts.
 - The delay of the RWA Harness (Milestone A1) has rippled impacts throughout the spacecraft. The team hopes to have overcome the challenges.
 - Instrument delivery (Milestone B2) has slipped and is driving the Critical Path.
- On the Critical Milestones Chart:
 - The Communications Equipment Module Harness has been delivered, but much later than expected. Impacts are being assessed in the schedule.
 - Work on the Power Equipment Module Harness has not began as originally planned.
 - The Kinematic Mounts are a critical delivery.

What financial/business implications does this technical/schedule news have on the project?

Project XYZ Master Schedule

CASE #1: Problem



△ Event/Milestone Planned Start

▲ Event/Milestone Actual Start

▬ Planned Activity

▬ Actual Activity

▽ Event/Milestone Planned Complete

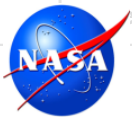
▼ Event/Milestone Actual Complete

◇ Anticipated Slip

◆ Actual Slip

▨ Funded Schedule Reserve

- - - Critical Path



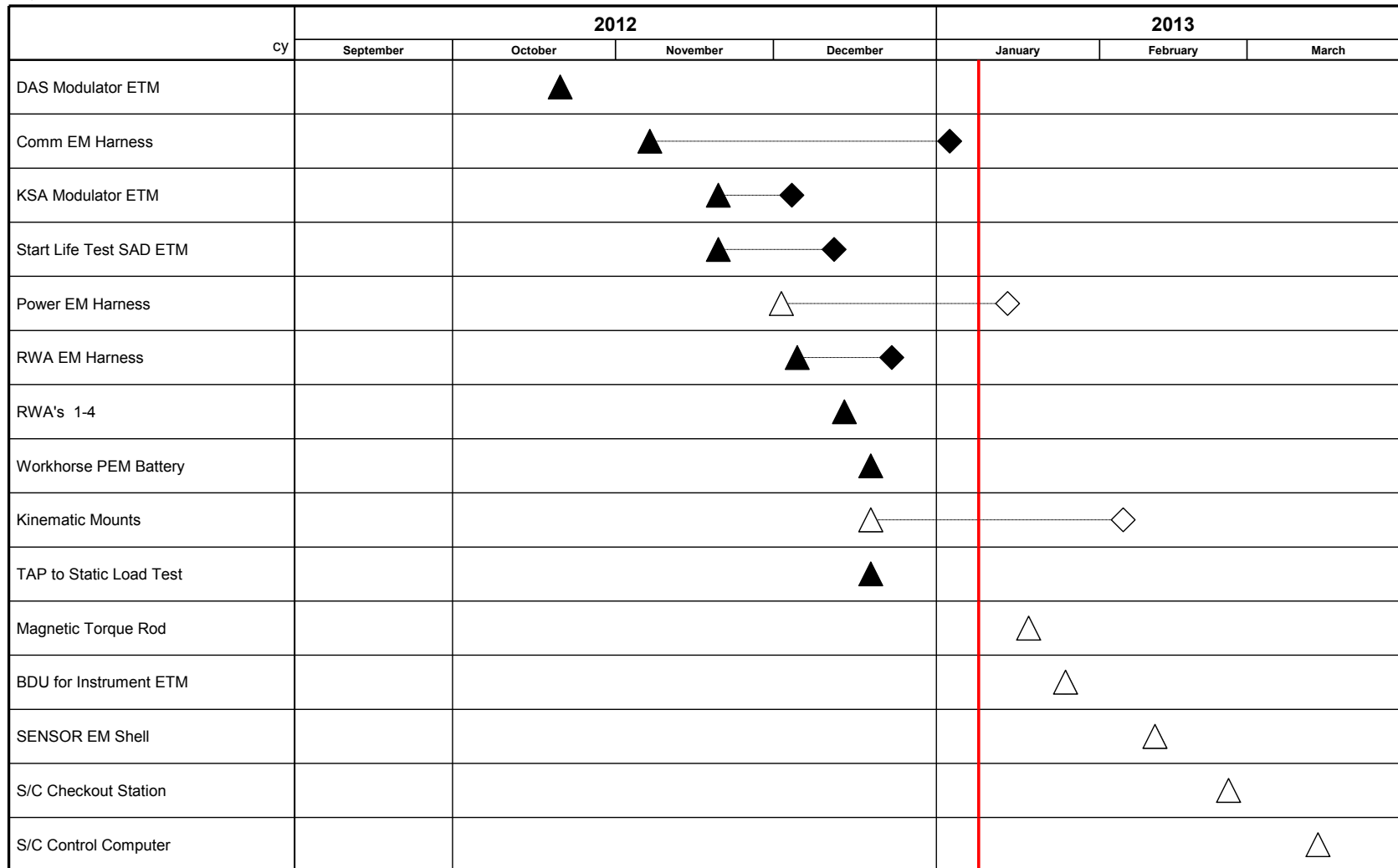
Project XYZ

Critical Milestones

CASE #1: Problem

Page 1 of 2

1/8/13



△ Plan

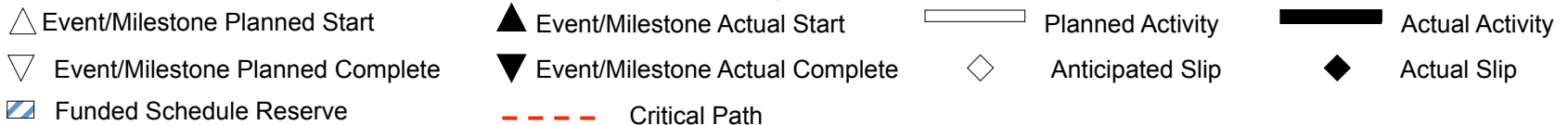
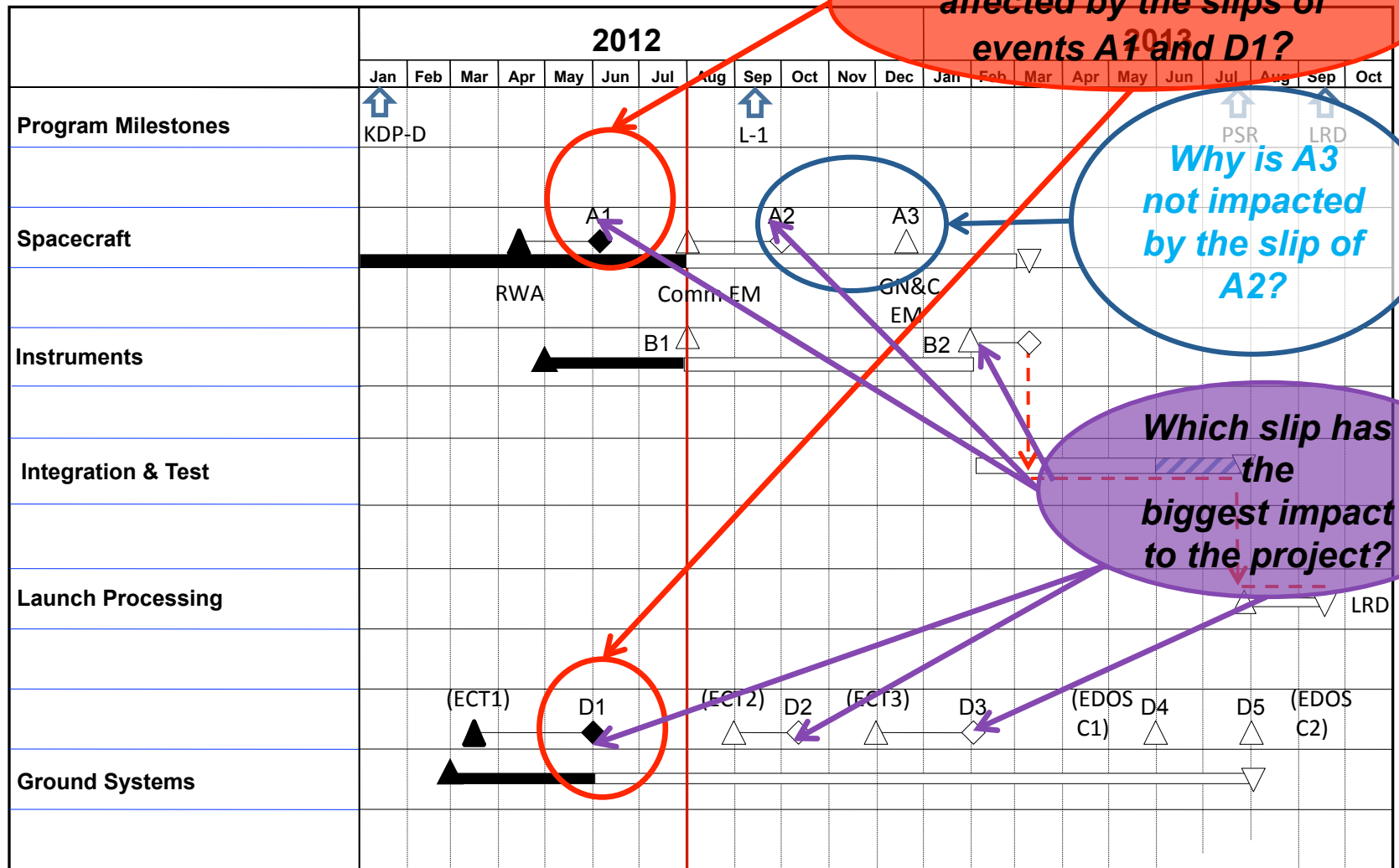
▲ Actual

◆ Actual Slip

Case Study # 1

Solution

Possible Solution



Possible Solution

CASE #1:

What questions could you ask?

- What activities were affected by the slips of events A1 and D1?
- Why is A3 not impacted by the slip of A2?
- Does the slip of A2 impact any other activity or event?
- Which slip has the biggest impact to the project?
- Why are all the slips in the near-term not impacting downstream events?
- What implications does the Comm EM delay have?
- Why hasn't the work on the Power Equipment Module Harness started? Will it cost more? Are we mitigating with more staff?
- How can we keep the Kinematic Mounts on schedule?
- Other questions to technical leads?

What do they mean to you?

Without additional information, none of these questions can be answered.

But they need to be.

Why? The bottom line is that the bar chart schedule is a project tracking and control tool. It enables a project to measure its performance to a baseline, or original, schedule and visualize what lies downstream for schedule objectives. **To perform analysis of the impacts requires either an intuitive evaluation or some other methodology, such as networking.**

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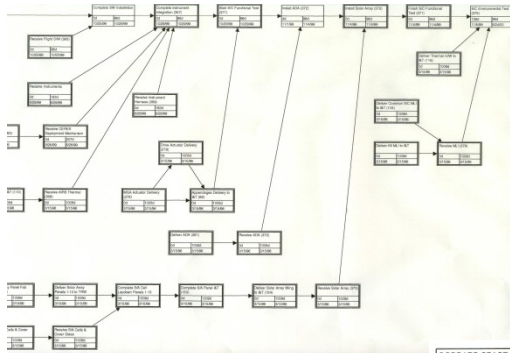
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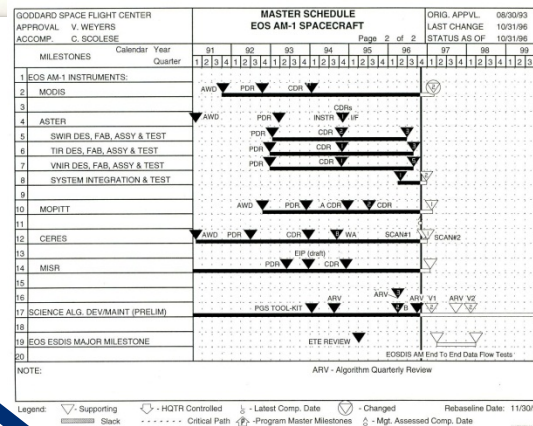
Workshop

Part 2

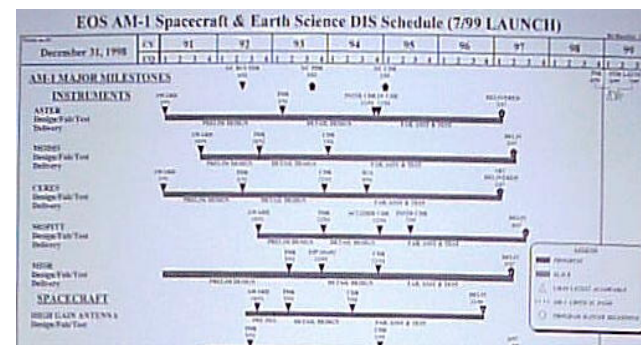
Schedules: Vertical Traceability



Detailed milestones & networks
(e.g. spacecraft assemblies)



Intermediate Schedule
(e.g. spacecraft)

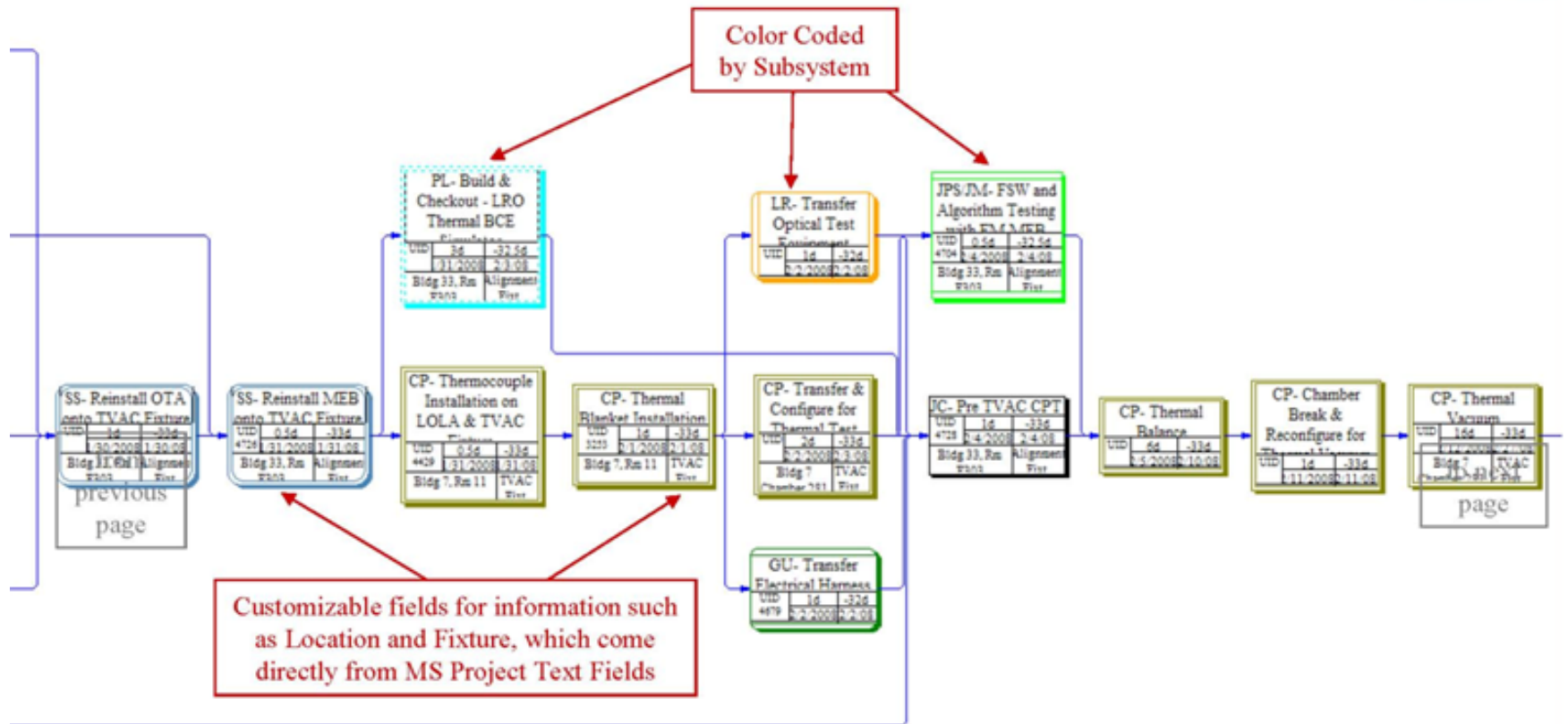


Master Schedule
(Mission)

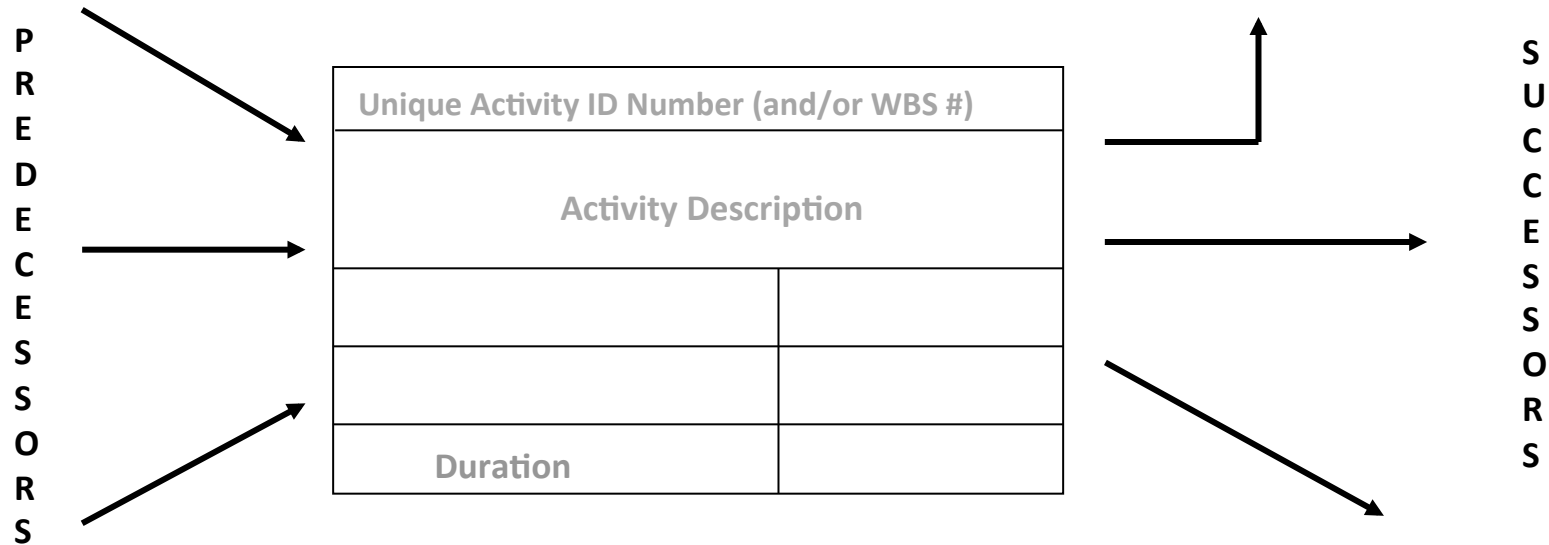
Section of a Logic Network

Legend:

Task Description			
UID	Duration	Slack	
Start Date		Finish Date	
Location		Fixture	



Build the Activity Relationships*



- Identify Preceding and Succeeding Activities

* Also known as Constraints or Dependencies

Constraint Template

Determining the constraint and lag relationship between two activities is as simple as filling in the blanks:

Predecessor
(Tail Activity #)

Must

Start or Finish


At Least _____ Units

Lag + or -
(Constraint Delay)

Before _____
Successor
(Head Activity #)

Starts or Finishes

Legend:

Tail =  =Head
(of the connecting arrow)

Case Study # 2

Managing a Change to the Plan

Case Study # 2

Part A

The Plan Changes!

CASE #2: Problem

- After the Monthly Review, XYZ Project assesses the schedule and technical progress and notes a few changes.
- While the plan is being reworked, you overhear a few different hallway conversations regarding the project. You note:
 - Long-Lead procurements must start ASAP.
 - In Assembly of the instrument, we are sharing tooling carts and dolly's with Project ABC to save costs.
 - The I&T Manager is debating with the Systems Engineer on what approach to take for testing. Needing to save time to maintain the Launch date is important. The key point of question is will the project be doing Thermal Vacuum testing in-house or at the contractor's facility?

What financial/business implications does this technical/schedule news have on the project?

Case Study # 2A

Solution

Possible Solution

CASE #2:

What questions could you ask?

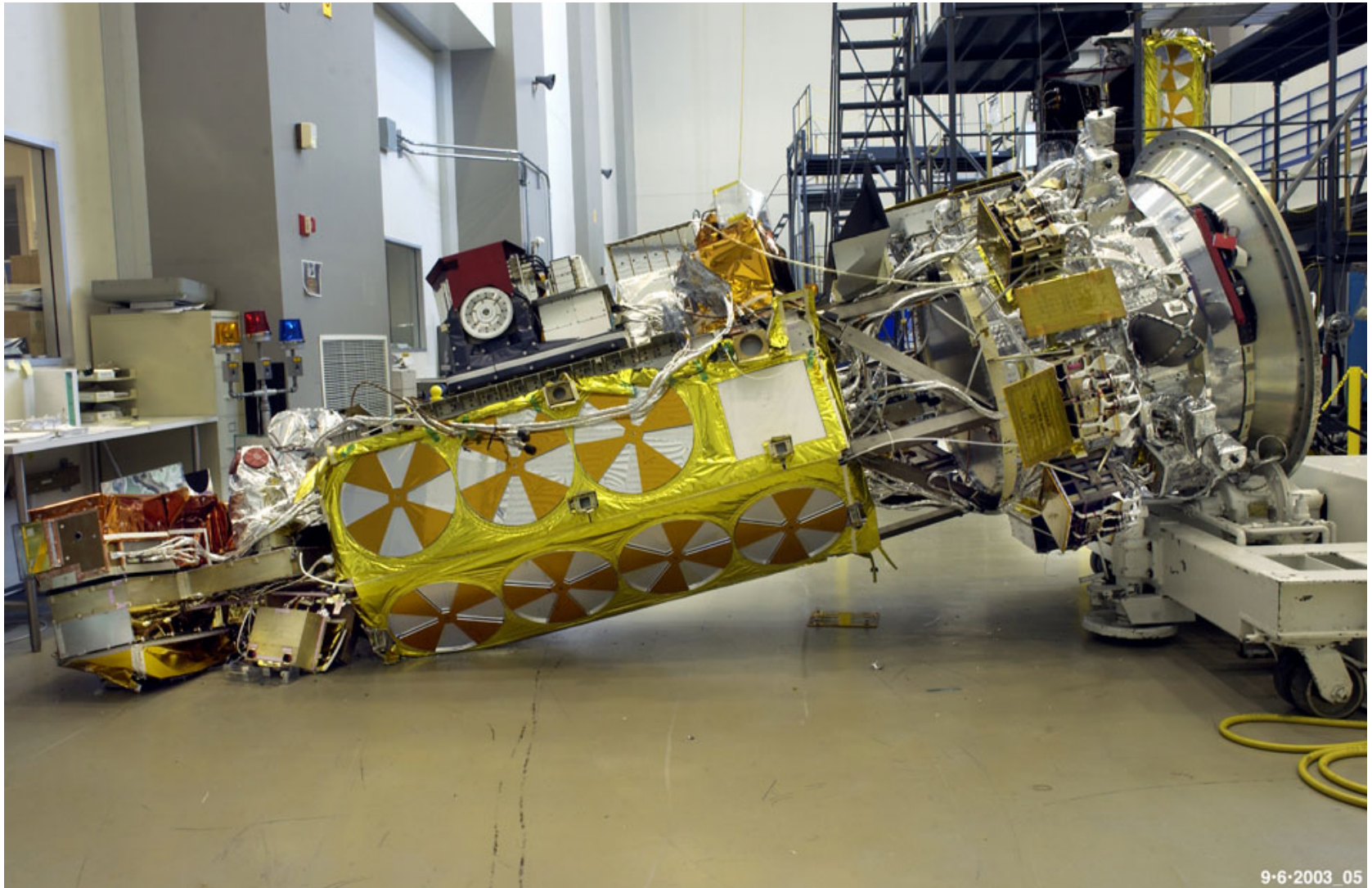
- Long-Lead procurements must start ASAP:
 - Procurement can start 30 days after design starts - - are these approved parts?
 - Are these competitive bid or off-the-shelf items? If competitive bid (in-house estimate required, proposal evaluations) will you have adequate time to get the parts when needed?
- In Assembly, we are sharing equipment with Project ABC to save costs:
 - Will there be any conflicts in schedule?
 - Are we using the same technicians to do the work?
 - Will work be done during non-regular hours (off shift or weekends)?
 - What are our workforce requirements? Will there be impacts if delays take place?
 - Are risks accounted for? (POES NOAA N Prime example (picture follows))
- Will the project be doing Thermal Vacuum testing in-house or at the contractor's facility?
 - If in house, are we sharing the chamber with other projects? What could impact our schedule?
 - If out-of-house, have we considered delivery requirements – back and forth between facilities?
 - What are our workforce and resources requirements?

Informational Slide Only

POES NOAA N Prime “MISHAP”

CASE #2:

You can't always plan for the unexpected, but you can take precautions.



9-6-2003_05

POES Mishap Background

Informational Slide Only

CASE #2:

Description of the Event:

- Date of Mishap: September 6, 2003
- As the NOAA-N Prime spacecraft was being repositioned from vertical to horizontal on the "turn over cart" at approximately 7:15 PDT today, it slipped off the fixture, causing severe damage. The 18' long spacecraft was about 3' off the ground when it fell.
- The mishap was caused because 24 bolts were missing from a fixture in the "turn over cart". Two errors occurred. First, technicians from another satellite program that uses the same type of "turn over cart" removed the 24 bolts from the NOAA cart on September 4 without proper documentation. Second, the NOAA team working today failed to follow the procedure to verify the configuration of the NOAA "turn over cart" since they had used it a few days earlier.

POES Mishap Background

Informational Slide Only

CASE #2:

Summary of Findings:

- Complacency impaired the team directly performing the operation and those providing supervision or oversight to this team. The operation was consistently characterized as routine and low risk, even though it involved moving the spacecraft.
- Several other adverse mental states, including fatigue and external constraints that limited the availability of portions of the crew to a half day.
- Incomplete coordination concerning ground equipment use and status, and late notification of operation schedules exacerbated the lack of rigor in handling operations.
- There is no Project in-plant civil servant government presence. The Project in-plant government representatives (one in quality assurance, two in I&T) were past employees of LMSSC and were hired as outside contractors by the GSFC Project

POES Mishap Background

Informational Slide Only

CASE #2:

Findings Relative to Resources Management:

- GSFC project in working to deal with a declining workload and resources, allowed and even encouraged trade-offs between the schedules, staffing and milestones for the two remaining satellites in the Polar Operational Environmental Satellite (POES)/(TIROS) project. These constant and rapid trade-offs exacerbated the already fast operational tempo of the LMSSC I&T team.
- Organizational climate was found to be an issue, primarily in the government on-site structure. There is no Project in-plant civil servant government presence. The Project in-plant government representatives (one in quality assurance, two in I&T) were past employees of LMSSC and were hired as outside contractors by the GSFC Project. The MIB believes that their past associations with the company might precipitate undue complacency due to familiarity. Likewise lacking is the government organizational oversight to monitor, verify, and audit the performance and effectiveness of the I&T processes and activities

Questions Beyond the Case

Informational Slide Only

CASE #2:

- Does the schedule have the working calendar(s) properly defined?
 - Holidays, non-working days, shifts?
- If using MSProject, are dates calculated manually (default) or automatically?
- Are the durations realistic for activities?
 - This takes experience and knowledge from technical staff
- What resources will be required to achieve the schedule? Are they accounted for?
 - Facilities, logistics, tools and tooling, test equipment, GFE, transportation equipment, etc...

Always Remember: Who, What, When, Where,
How and Why can = \$'s

Case Study # 2

Part B

The Plan Changes!

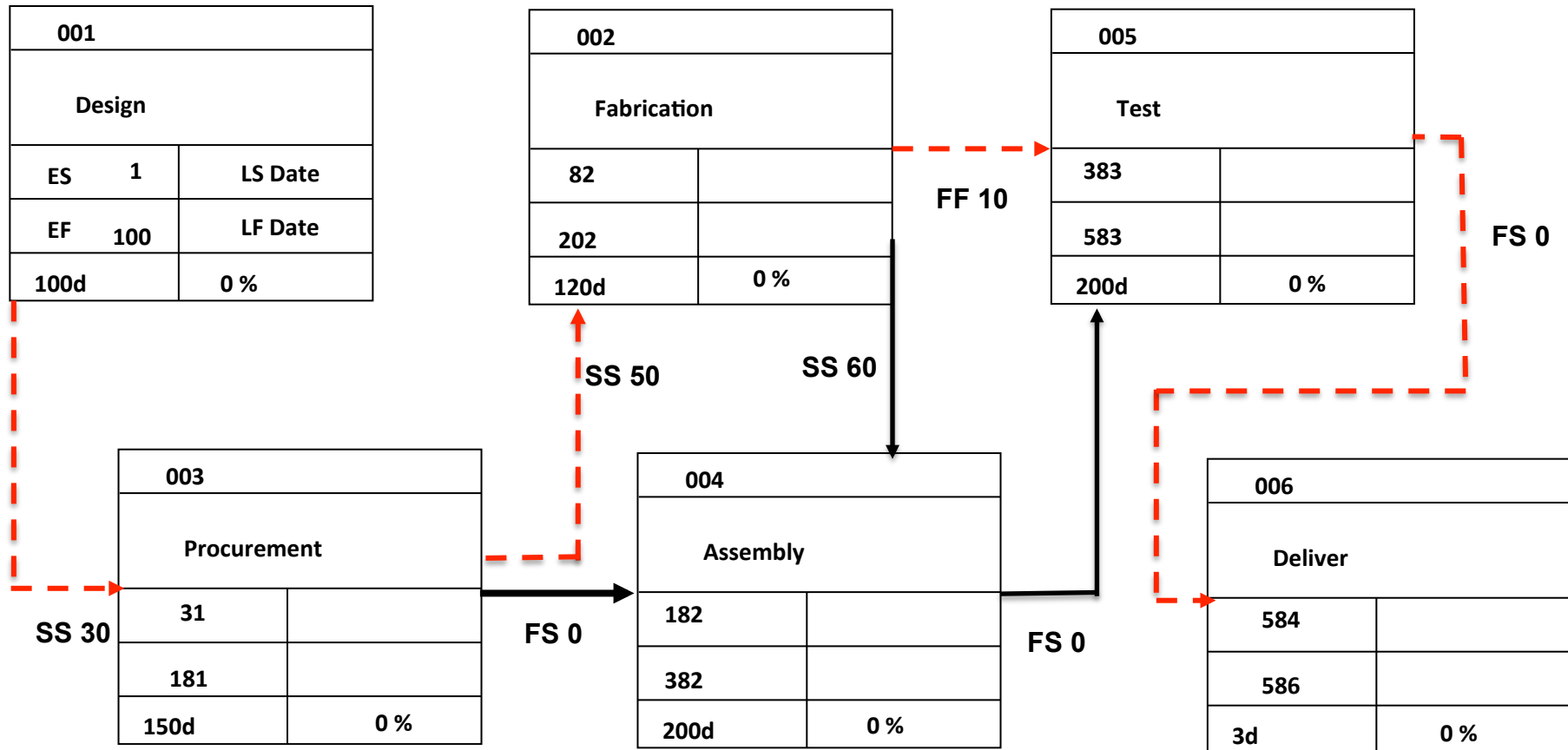
CASE #2: Problem

- Additionally, you learn that on the electrical harness subsystem durations of some activities were increased. Thanks to your time learning about the importance of schedules, you have spent some time with Project XYZ's planner. The planner provided you with a copy of the revised subsystem network (refer to the next page).
- From your discussions with the harness manager, you learn that:
 - Fabrication increased by 30 working days
 - Testing increased by 60 working days
 - These changes did not impact facility usage or material costs
- Baselined budgets and planned workforce did not include this increase of time. **Original** workforce staff (in Full-Time Equivalent (FTE)) and annual average labor rates (fully loaded) are:
 - Fabrication: 8 FTE at \$180 K per year per FTE
 - Test:
 - 4 Technicians at \$110 K per year per FTE
 - 3 Engineers at \$180 K per year per FTE

Given the information, what is the impact on FTE and budgets with the change?

Revised Project XYZ Network

CASE #2: Problem



--> = Critical Path
 Schedule specifies 260 working days per year

Case Study # 2 B

Solution

Possible Solution

CASE #2:

What questions could you ask?

- Long-Lead procurements must start ASAP:
 - Procurement can start 30 days after design starts - - are these approved parts?
 - Are these competitive bid or off-the-shelf items? If competitive bid (in-house estimate required, proposal evaluations) will you have adequate time to get the parts when needed?
- In Assembly, we are sharing equipment with Project ABC to save costs:
 - Will there be any conflicts in schedule?
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 - Will work be done during non-regular hours (off shift or weekends)?
 - What are our workforce requirements? Will there be impacts if delays take place?
 - Are risks accounted for? (POES NOAA N Prime example (picture follows))
- Will the project be doing Thermal Vacuum testing in-house or at the contractor's facility?
 - If in house, are we sharing the chamber with other projects? What could impact our schedule?
 - If out-of-house, have we considered delivery requirements – back and forth between facilities?
 - What are our workforce and resources requirements?

Solution

CASE #2:

Given the information, what is the impact on FTE and budgets with the change?

- From your discussions with the harness manager, you learn that:
 - Fabrication increased by 30 working days
 - Testing increased by 60 working days
 - Fabrication: 8 FTE at \$180 K per year per FTE
 - Test:
 - 4 Technicians at \$110 K per year per FTE
 - 3 Engineers at \$180 K per year per FTE
- From your discussions with the harness manager, you learn that:
 - Fabrication: FTE increase of 0.92 $(=(30/260)*8)$; \$166 K increase $(\$180K * 0.92)$
 - Testing:
 - Technicians: FTE increase of 0.92 $(=(60/260)*4)$; \$101 K increase $(\$110K * 0.92)$
 - Engineers: FTE increase of 0.69 $(=(60/260)*3)$; \$125 K increase $(\$180K * 0.69)$

Workshop

Part 3

Resources

- Resources on a project will include (but certainly not be limited to):
 - Budget, time, facilities, tooling, materials, workforce, pencils and paper, etc.
 - Most resources can be replenished or refurbished.
- Replenish time and cost increases. Replenish dollars, time can remain the same.
 - The relationship between Cost and Schedule is critical project management.
 - Earned Value Management (EVM) is a well established method for establishing and reporting this relationship.

Time is the only resource that cannot be replenished without impacting all of the others!

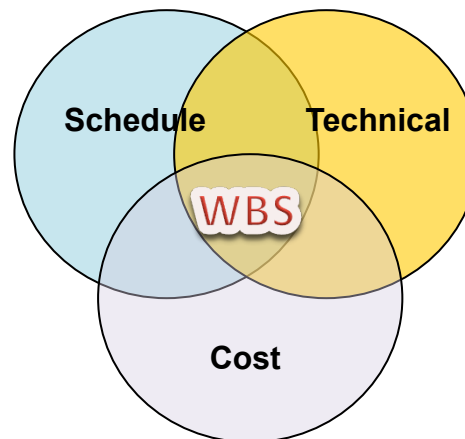
Resources Emphasis by Phase

Phase A:	Understanding new technology and requirements can make scheduling and budgeting challenging. Expect many changes and replans as available resources and scope change.
Phase B:	Costs and Schedule are baselined (approved at the end of Phase B). Early development activities can be in flux and are risky. However, the planning portion of budgets and schedule should become firm.
Phase C/D:	As flight hardware is procured, integrated and tested, problems are uncovered. Make sure sufficient cost and schedule reserves exist to cover for an unknown risks and additional testing (if required).
Phase E/F:	Level of effort costs should be well understood with little variation for mission operations (little cost reserves needed). Costs of shutdown/disposal (e.g. safe reentry).

Each Phase has unique activities that can impact schedule and cost

The Intersection of Cost, Technical and Schedule

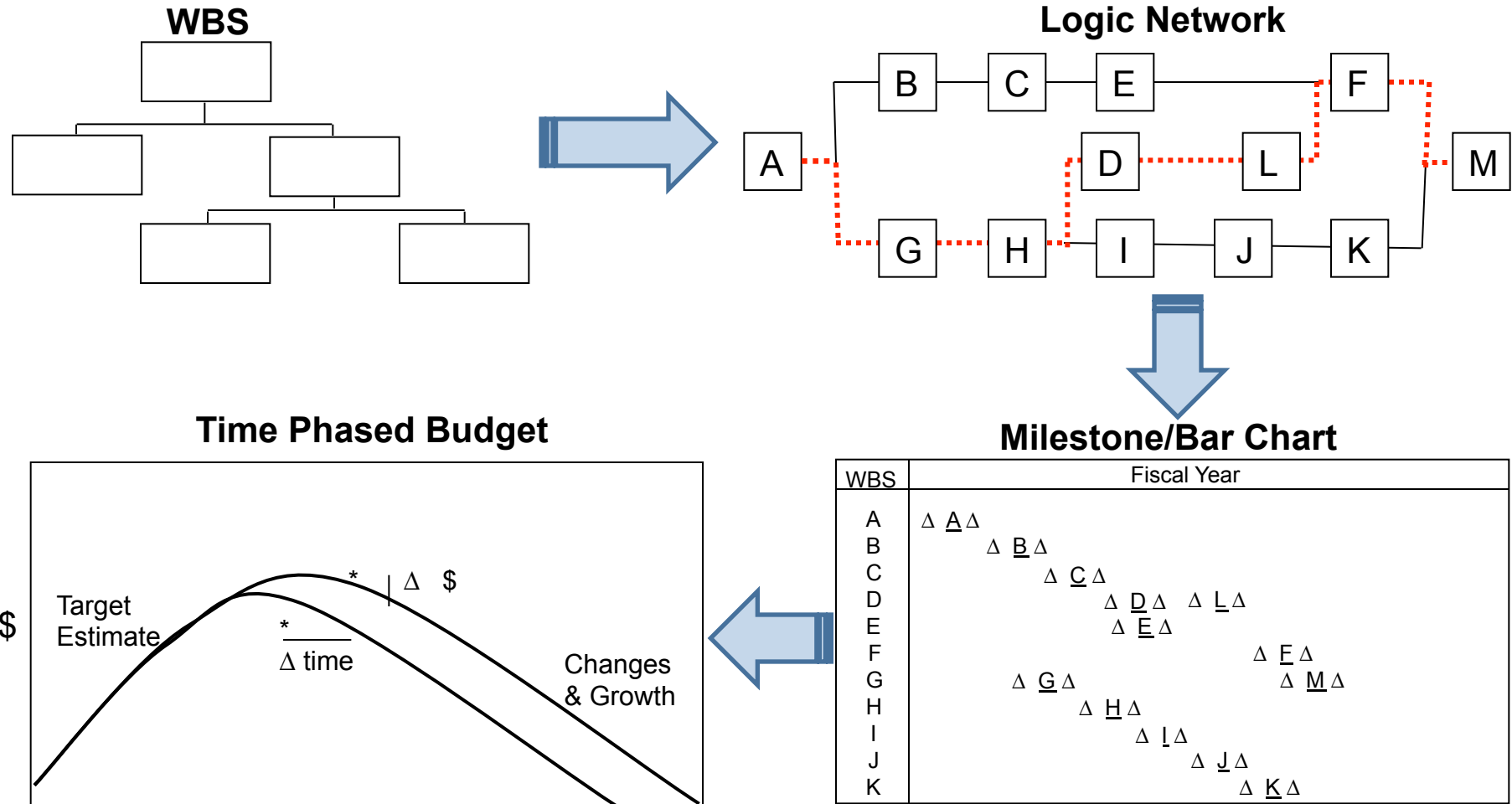
- A well defined WBS is important to establish the link between the technical, scope, schedule and budget
 - Integrates all elements of a project as a function of logic and time
 - Helps with executing Earned Value Management
 - Provides a common communication base
 - Identifies the scope of work
 - Helps with time phasing and resource loading budgets
 - Balances time with budget availability



Having the technical lead, scheduler and Resources Staff connected with a common and aligned WBS helps bring it all together

Integral Tie Between WBS, Schedules, and Budgets

Schedules are the result of the planning and control process

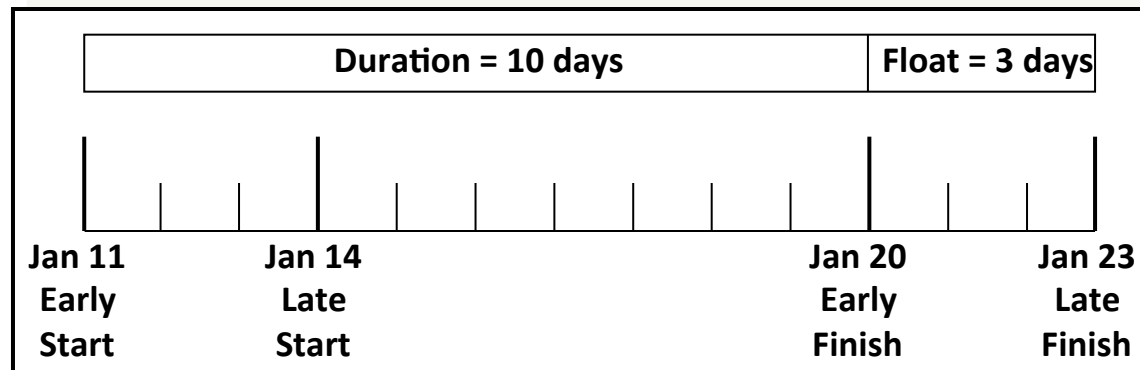


Case Study # 3

Budget Estimates and Reserves
Will you have Enough?

Float/Slack

CASE #3: Supporting Information



- [Total Float](#) is normally defined as:
 - The amount of time units by which activities can be delayed without delaying the completion of project or intermediate project activities.
 - The activities having the least amount of total float are on the “Critical Path” or paths.
- [Free Float](#) is the amount by which an activity can be delayed without affecting succeeding activities.
- [Calendar Float](#) is the amount of non-working time (off shifts, holidays and weekends) available to a project.

Impacted Reserves

CASE #3: Problem

- After the recent re-plan on Project XYZ and issues identified, the project puts forward a new schedule for the upcoming Monthly Review. The schedule now loses one month of funded schedule reserve. The original and revised Monthly Review chart follow in the next pages.

What financial/business implications does this technical/schedule news have on the project?

- Some questions to consider:
 - Why is it important to the Resources people to understand how much calendar float there is in a project?
 - If an activity is two weeks long and has three days of free float, how does the RA spread labor dollars?

Impacted Reserves

CASE #3: Problem

- Your Project Manager requested a deeper understanding of what the schedule impacts have done. While the project consumed one month of funded schedule reserve, the PM is concerned that there could be additional impacts that are unknown.
- Some information:
 - The funded schedule reserve was valued at \$500 K per month originally, for a total of 2 months.
 - This time frame and dollar value was based on the I&T burn rate of the project staff at the end of I&T activities (since all of the funded schedule reserve was held in Phase D (near the end of the project)).
 - The average monthly burn rates for other areas of the project are:
 - Spacecraft: \$850 K per month (at peak workforce)
 - Instrument: \$1,200 K per month (at peak workforce)
 - Ground: \$80 K per month (at peak workforce)
- Does use of the funded schedule reserve have any additional financial impacts based on the schedule information? Does the project need to consider any liens or encumbrances?
- What types of elements beyond this would you need to consider to price out the full impact impact?

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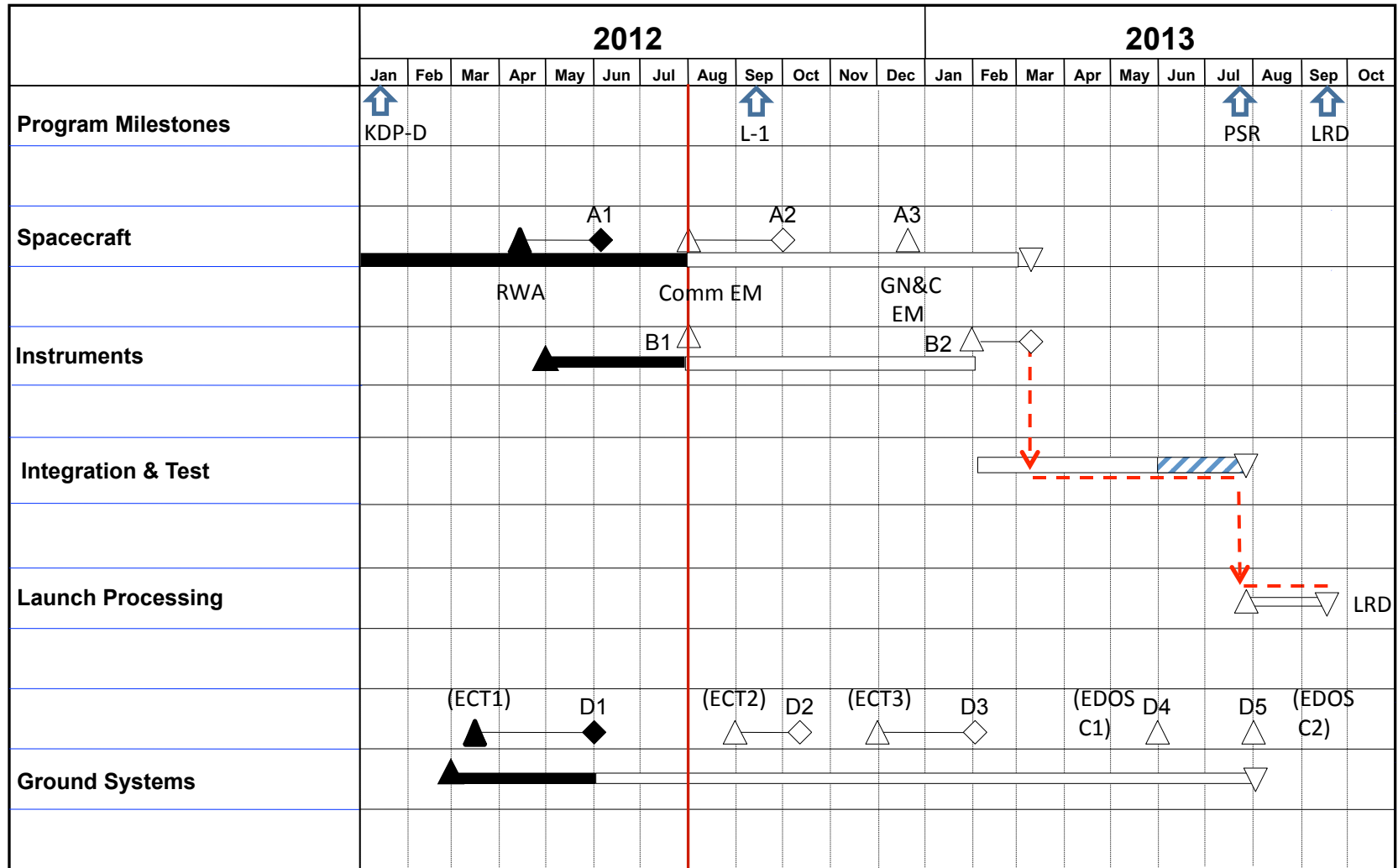
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Project XYZ Master Schedule

CASE #3: Problem



△ Event/Milestone Planned Start

▲ Event/Milestone Actual Start

▬ Planned Activity

▬ Actual Activity

▽ Event/Milestone Planned Complete

▼ Event/Milestone Actual Complete

◇ Anticipated Slip

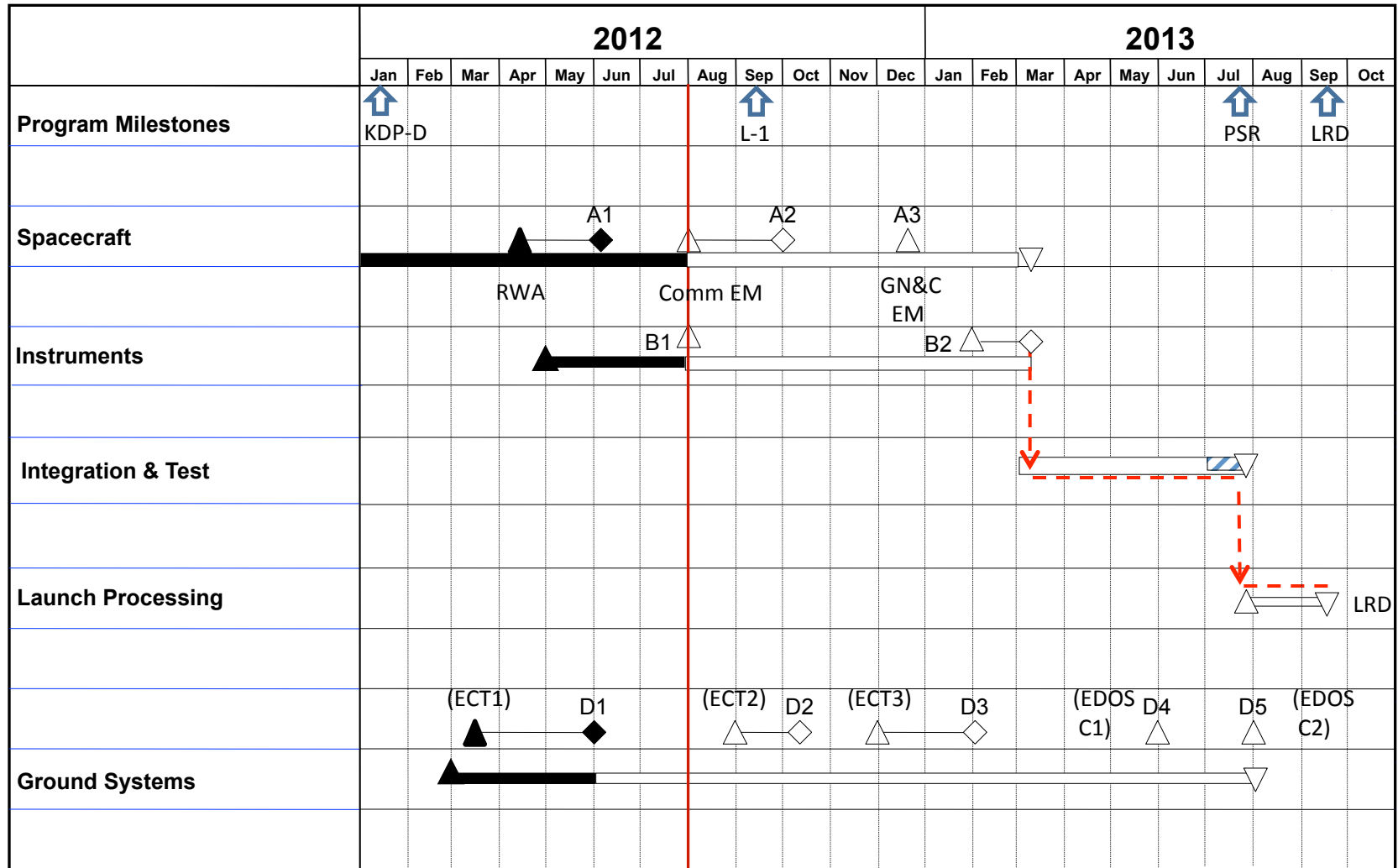
◆ Actual Slip

▨ Funded Schedule Reserve

- - - Critical Path

Project XYZ Revised Master Schedule

CASE #3: Problem



△ Event/Milestone Planned Start

▲ Event/Milestone Actual Start

▬ Planned Activity

▬ Actual Activity

▽ Event/Milestone Planned Complete

▼ Event/Milestone Actual Complete

◇ Anticipated Slip

◆ Actual Slip

▨ Funded Schedule Reserve

- - - Critical Path

Case Study # 3

Solution

Possible Solution

CASE #3:

- Does use of the funded schedule reserve have any additional financial impacts based on the schedule information?
 - Answer: Likely yes. The schedule shows additional time on the instrument and a loss of I&T funded reserve. Based on the peak burn rates, the project may have a problem.
 - **Lesson: Where funded schedule reserved is bookkept matters.**
- Does the project need to consider any liens or encumbrances?
 - Answer: Likely yes. If time was impacted at the peak workforce, the damage could be \$700 K (Instrument monthly peak \$1,200 K – Funded Schedule Reserve time shifted to Instrument \$500 K = \$700 K lien/encumbrance to cover staffing impact)
- What types of elements beyond this would you need to consider to price out the full impact?
 - Answer: “Marching army” cost, HW storage & maintenance, contractor workforce support, travel costs, etc.
- **There are multiple ways to view schedules and plans to learn new information...**

EOS AM-1 INTEGRATION & TEST

MONTHS TO LAUNCH: 11

Completed: Could resources be moved?



GSE

CALIBRATION
MECHANICAL ASSY
ELECTRICAL ASSY
FUNCTIONAL C/O
ENVIRON. TEST & CALIB.

Completed: Could resources be moved?



GSE

FM-1

MECHANICAL ASSY
ELECTRICAL ASSY
FUNCTIONAL CHECKOUT
ENVIRON. TEST & CALIB.

FM-2

MECHANICAL ASSY
ELECTRICAL ASSY
FUNCTIONAL CHECKOUT
ENVIRON. TEST & CALIB.



GSE

CALIBRATION
MECHANICAL ASSY
ELECTRICAL ASSY
FUNCTIONAL CHECKOUT
ENVIRON. TEST & CALIB.

Completed: Could resources be moved?



MECHANICAL ASSY



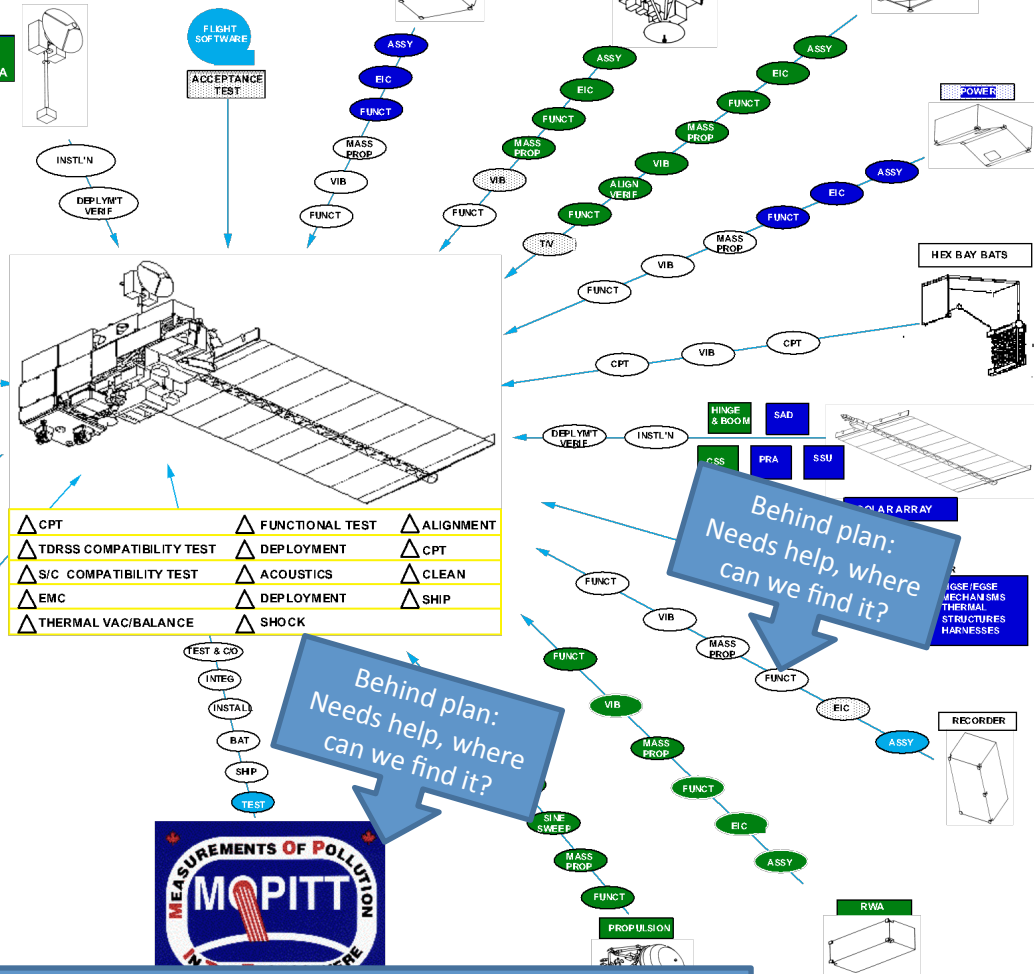
LEGEND:

- ~25% COMPLETE
- ~50% COMPLETE
- ~75% COMPLETE
- 100% COMPLETE
- ETM WORKAROUND
- △ SYSTEM LEVEL TESTS

July 31, 1997

Source: C.Scolese/J.Bryson/S.Brill

Regardless of format schedule information is presented in, when the Resources staff recognize that hardware is falling behind schedule what flags should be raised and what mitigations can be done?



Behind plan:
Needs help, where
can we find it?

Behind plan:
Needs help, where
can we find it?

Workshop

Closing Thoughts

Scheduling for the Resources Community: Summary

- Schedules are “Working Tools;” no more, no less
- Stay involved and help schedulers and technical leads remember the linkage between scope, schedule, and cost
 - The Requirements, WBS, and schedule flow needs to be as accurate as possible before a project plans thousands of activities
 - If it isn’t right, don’t move forward
- Have a good relationship with your project scheduler
 - Ask to spend time with them. Review your particular project/program level schedule (s)
- Talk to the technical leads and individuals performing the work:
 - Does the schedule make sense?
 - What/where are the concerns? Think of areas for budget risk
 - Visit the shop floor – see for yourself what the hardware status is

Scheduling for the Resources Community: Summary

- Ownership of the Schedule goes to those responsible for accomplishing its tasks.
 - Question the owners (PDLs, engineers, scientists, managers, and others) if a schedule does not make sense
 - Coordinate meetings with them to make sure that in budget discussions, schedule is addressed too
- Check to match durations of activities with budgets.
 - If durations for specific activities or WBS numbers are longer or shorter than the allocated budget, you have a problem
- Monitor the schedule for potential problems or major changes in float/slack to identify where cost reserves are needed.

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- Jim Mannion and Bernie Cullinan

Questions

